A POLARIMETRIC MODEL FOR EFFECTS OF BRINE INFILTRATED SNOW COVER AND FROST FLOWERS ON SEA ICE BACKSCATTER

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A polarimetric scattering model is developed to study effects of snow cover and frost flowers with brine infiltration on thin sea ice. Leads containing thin sea ice in the Arctic icepack are important to heat exchange with the atmosphere and salt flux into the upper ocean. Surface characteristics of thin sea ice in leads are dominated by the formation of frost flowers with a high salinity. In many cases, the thin ice layer is covered by snow, which wicks up brine from sea ice due to capillary force. Snow and frost flowers have a significant impact on polarimetric signatures of thin ice, which needs to be studied for assessing the retrieval of geophysical parameters such as ice thickness.

Frost flowers or snow layer is modeled with a heterogeneous mixture consisting of randomly oriented ellipsoids and brine infiltration in an air background. Ice crystals are characterized with three different axial lengths to depict the non-spherical shape. Under the covering multi-species medium, the columnar sea-ice layer is an inhomogeneous anisotropic medium composed of ellipsoidal brine inclusions preferentially oriented in the vertical direction in an ice background. The underlying medium is homogeneous sea water. This configuration] is described with layered inhomogeneous media containing multiple species of scatterers. The species are allowed to have different size, shape, and permittivity. The strong permittivity fluctuation theory is extended to account for the multi-s] species in the derivation of effective permittivities with distributions of scatterer orientations characterized by Eulerian rotation angles. Polarimetric backscattering coefficients are obtained consistently with the same physical description used in the effective permittivity calculation.

The multi-species model allows the inclusion of high-permittivity species to study effects of brine infiltrated snow cover and frost flowers on thin ice. First, theoretical results for bare saline ice are compared with measured data obtained with a JPL C-band polarimetric scatterometer during CRRELEX '93. Then, the covering layer is included to simulate the frost or snow cover with brine infiltration. Small-scale roughness at medium interfaces is also considered. The roughness characterizes bumps or small protrusions, which serve as nucleation sites for the growth of frost flowers. The roughness can also result from the refreezing of the liquid phase at the snow-ice interface. The results suggest that the frost cover with a rough interface significantly increase the backscatter from thin saline ice and the polarimetric signature becomes closer to the isotropic characteristics. The snow cover also modifies polarimetric signatures of thin sea. ice depending on the snow mixture and the interface condition.